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PATENT ABSTRACTS OF JAPAN, vol. 8, no. 241 (C-250)[1678], 6th November 1984

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Description

Periodontal disease is an inflammatory disorder of the supporting tissue of teeth. Without control, chronic inflammatory condition associated with periodontal disease will destroy tissue supporting teeth and eventually result in teeth loss.

Attempts have been made to alleviate periodontal disease using chemical agents. For example, US Patent No. 4,789,662 to Thomas-Leurquin et al. discloses a pharmaceutical composition including collagen and a chlorhexidine antiseptic and anti-inflammatory substance. However, the traditional mode of prevention and treatment of periodontal disease has centered on maintaining good oral hygiene. This consists of, among other things, removal of dental plaque which is considered to be the etiological cause of dental caries and periodontal disease. Dental plaque consists of microbial masses which deliver a stream of enzymes, endotoxins and exotoxins onto gingival and marginal periodontal tissue leading to inflammation. The resulting inflammatory response triggers a series of catabolic processes. Specifically, as tissue reacts to protect itself from these toxic assaults, complex changes occur in the immune system in the function of osteoclasts, in the activity of lymphocytes in the blood streams, and in other bodily defenses. These changes and complement activation lead to increased prostaglandin formation at the inflammation site.

Prostaglandin, and related compounds, are principally formed by body cells at the site of tissue injury by a process known as arachidinic acid cascade. This process occurs when essential fatty acids, especially linoleic acid, are enzymatically converted into arachidonic acid, which in turn is further metabolized through either the cyclooxygenase or lipoxygenase pathways to prostaglandins (PGS).

Prostaglandins, particularly prostaglandin-E_2 (PGE_2), have been implicated as components of the inflammatory reaction. Goods on et al., Prostaglandins, 6, 81-85 (1984) and El Attar et al., J. Periodontal, 52, 16-19 (1981) demonstrated that PGE_2 levels are elevated in inflamed gingiva when compared to normal gingiva. Offenbacher et al., J. Perodont. Res., 21, 101-112 (1986) demonstrated that extremely high levels of PGE_2 are present ar periodontal sites of active attachment loss and low at sites which are in remission, i.e. there is no longitudinal attachment loss. The PGE_2 level is diseased tissue approximates 1 µM (Offenbacher et al., J. Periodon. Res. 19, 1-13 (1984)) which is a pharmacologically active concentration when tested in various model systems to induce vasodilation, bone resorption and other pro-inflammatory responses.

Despite this evidence regarding the key role of PGE_2 in the pathogenesis of periodontal disease, there has been substantially little appreciation of the use of drugs which inhibit PGE_2 synthesis in an attempt to retard or prevent periodontal tissue destruction.

Accordingly, an object of the invention is the use of topical compositions for the manufacture of a medicament which inhibit prostaglandin formation and are therefore useful for the treatment of periodontal disease.

These other objectives are achieved by providing a synergistic composition which comprises an antioxidant in combination with an arylpropionic, non-steroidal anti-inflammatory drug (NSAID).

Antioxidants reduce the oxidation of arachidonic acid by competing for enzymatically formed oxygen radicals during arachidonic acid cascade. The result of this competition is a decrease of prostaglandin synthesis and a concomitant decrease in plaque-induced gingival inflammation in addition to the tissue destruction which is associated therewith. Non-steroidal anti-inflammatory drugs (NSAID) treat inflammation, but have limited effectiveness in fighting the underlying disease origins of the inflammation. EP-A-0279867 and Rivista di Farmacologia e Terapia, XIII, 27-34, 1982, describe the use of NSAIDs, e.g. ibuprofen, aspirin or indomethacin to enhance the anti-inflammatory effect of vitamin E (alpha-tocopherol). Patent Abstracts of Japan, Vol 8, No. 241 (c-250) [1678] November 6, 1984 describes the use of NSAIDs such as ketoprofen in an analgesic gel for the oral cavity. This invention concerns the use of ketaprofen with alpha-tocopherol as an oral topical treatment for periodontal disease.

According to the present invention, there is provided the use of an anti-inflammatory drug in the preparation of a pharmaceutical composition for the topical treatment of periodontal disease to prevent destruction of tissue supporting the teeth, characterised in that ketoprofen is used as the anti-inflammatory drug in combination with alpha-tocopherol in a carrier comprising a semi-solid paste, gel, liquid, ointment or film which has a strong and continuing adherence to the oral mucosa, the amounts of anti-inflammatory drug and alpha-tocopherol each being from 0.01 to 10% by weight of the composition.

In the determination of the synergistic activity of the compositions according to the present invention, the following in vitro testing was effected. A large pool of inflamed human gingival tissue was obtained from patients with periodontitis who were undergoing routine periodontal surgery. The tissues were immediately stored in liquid nitrogen prior to use or were used fresh. The assay of cyclooxygenase products was performed as a modification of the assay of El Attar et al., J. Periodon. Res., 21, 169-176 (1986). Pooled tissue was weighed and homogenized at 0-4°C with a Polytron^R (Brinkman) homogenizer in a 0.2 M TRIS buffer, pH 8.0, at a final concentration of 20 mg/ml. After centrifugation for 10 minutes at 1200 x g, the supernatant was divided into 3

ml aliquots for incubation in the presence or absence of a test compound.

The test compounds were tested in triplicate over a concentration range of 10^{-8} to 10^{-14}M. For example, alpha-tocopherol from 10^{-12} to 10^{-14}M was coupled with ketoprofen from 10^{-8} to 10^{-14}M range in a total of 3x7 matrix combinations in order to determine the synergistic effect as well as the IC_{50} (dosage concentration to reach 50% inhibition) of the combination.

Prostanoids were extracted as described by Powell, Methods in Eng., 86, 467 (1982) using a Sep-Pak-C_{18} (Trade Mark) cartridge from Waters Associates. The Sep-Pak was prepared by the sequential elution of 20 millilitres of ethanol and 20 millilitres of water. The sample was then adjusted to 15% ethanol, pH 3.0, with acetic acid and applied to the column. The column was eluted with 20 ml of 15% ethanol, pH 3.0, 20 ml of petroleum ether and then the prostaglandin Tx (thromboxane) was eluted with 10 ml of methyl formate. Thereafter, the methyl formate was evaporated to dryness with nitrogen and reconstituted in 32% acrylonitrile (high pressure liquid chromatography buffer).

Previous experience had revealed that the recovery was greater than 92% from PGE_2, PGI_2 (as 6KF1), TxA_2 (TxB_2) and PGF_2. These are readily separated and quantified using a 4.6 x 100 mm RP-18 Spheri-5u (Trade Mark) column from Brownlee Labs. A Flow-One (Trade Mark) radioactivity monitor simultaneously measured radioactivity while monitoring elution at 192 nanometers.

The net incorporation of the ^{14}C arachidonate was measured in the absence of the test substance in order to determine the maximum activity of the cyclooxygenase cascade.

The following Table 1 indicates the percent of control (maximum) PGE_2 synthesis as a function of alpha-tocopherol and ketoprofen concentration.

Table 1

Percent of PGE_2 Synthesis

In Presence of Ketoprofen and Alpha-Tocopherol

Alpha-tocopherol Concentration (M)	Ketoprofen Concentration (M)						
	10^{-14}	10^{-13}	10^{-12}	10^{-11}	10^{-10}	10^{-9}	10^{-8}
At 10^{-14}M	102	129	116	131	112	75	97
At 10^{-13}M	105	68	101	82	62	61	36
At 10^{-12}M	66	68	41	62	48	51	49

As can be seen from Table 1, the exemplary composition of alpha-tocopherol and ketoprofen in combination resulted in a synergistic effect in the inhibition of PGE_2. Specifically, alpha-tocopherol lowered in the IC_{50} value of ketoprofen and ketoprofen lowered the IC_{50} value of ketoprofen and ketoprofen lowered the IC_{50} value of alpha-tocopherol.

The compositions of the present invention include an effective periodontal disease reducing amount of the antioxidant and NSAID in combination with the pharmaceutically acceptable carrier. The amount of active ingredients in the composition are 0.01 to 10% by weight for alpha-tocopherol and 0.01 to 10% by weight for ketoprofen. The preferred weight % are 0.03 to 2.0% for alpha-tocopherol and 0.01 to 2.0% for ketoprofen.

According to the invention, the synergistic compositions are compounded into a carrier which has a strong and continuing adherence to the oral gingival mucosa. The carrier may then be applied to gingival tissues for two hours or longer in order to achieve a protracted topical therapeutic effect. Compositions of preferred vehicles which have acceptable properties are described herein as "mucosal-tenacious" and may be created from a variety of water-soluble or water-dispersible polymeric materials combined with other adjuvants.

All such materials used in the vehicle however, must have certain properties in common which are summarized below:

(1) They must be virtually non-toxic systemically.

(2) They must not irritate or damage bodily tissues at the site of the application.

(3) They must be water-soluble or water-dispersible polymeric molecules.

(4) They must be chemically and physically compatible with the synergistic composition.

(5) They must have a strong and persistent adherence to oral mucosal tissues, preferably for a minimum of 2 hours after application to effected tissues.

(6) They must allow the slow diffusion of the synergistic composition from the vehicle so that it can contact and permeate the mucosa at the site of application for protracted periods of time.

(7) They must be readily removable from the site of application by use of mild mechanical abrasion and a non-toxic detergent solution.

The mechanism by which a polymeric material bonds to oral mucosal tissues is complex. It is believed that chemical, physical and mechanical bonds form as permeation of molecules takes place into the irregularly contoured surface of the mucosal substrate. Since all body cells in vertebrate animals carry a net negative surface charge and most polymeric agents carry a net positive charge, an electrostatic bond develops due to coulombic attractions, van der Waal forces, hydrogen bonding and covalent bonding.

There are a number of polymeric agents which can be employed to prepare mucosal-tenacious vehicles with the seven required attributes enumerated above. Among these are natural gums, plant extracts, animal extracts, cellulose derivatives, polyvinyl alcohols, polyvinylpyrrolidone, polycarbophil, polyacrylic acid derivatives, polyacrylamides, ethylene oxide homopolymers, polyethelene-polypropylene copolymers, polyethylenimines and others.

It is important in selecting a composition for the mucosaltenacious vehicle that it allow the slow diffusion of the synergistic composition from the vehicle and into contact with the gingival tissues so that it can be absorbed into those tissues where it will induce its beneficial effects.

The chemical structures of the polymeric agent selected for use in the mucosal-tenacious vehicle of this invention are not nearly as important as their physical properties and ability to satisfy the seven conditions set forth above. However, a large number of materials can be selected which do satisfy these criteria if properly compounded at suitable concentrations into a vehicle such as a semi-solid paste, gel, liquid, ointment or film.

Among such agents are a number of natural hydrophilic polymeric agents, which are enumerated below:

(1) Agar, which is a hydrophilic colloid extracted from certain algae. It is relatively insoluble in cold water but soluble in hot water.

(2) Algin is derived from a brown algae, principally microcystitis pyriera. It is a linear polymer of high molecular weight; it is extracted principally as alginic acid and readily forms water-soluble alkali metal derivatives, amine derivatives and esters, all of which can be used in accordance with the teachings of this invention.

(3) Carageenan is another algae-derived water-soluble polymer and exists principally as the lambda, kappa and iota isomers.

(4) Other water-soluble polymers also derived from marine algae include fucoidan, laminoran and furcellaran.

(5) Gum arabic, also commonly called gum acacia, is the dried, gummy exudate of the acacia tree, indigenous to Africa, India, Central American and Southwest North America. It readily forms coacervates with gelatin.

(6) Gum ghatti is another tree exudate which has a higher viscosity in aqueous solutions than gum arabic.

(7) Gum karaya is a tree exudate with a high potential for water absorption and a relatively low pH. At concentrations of 5-20%, it is a strong wet adhesive.

(8) Gum tragacanth is widely used in food processing and is obtained from a perennial shrub found in the Near East.

(9) Guar gum is obtained from the guar plant in India and Pakistan and forms viscous, colloidal dispersions in water.

(10) Locust bean gum is derived from the fruit of the carob tree, an evergreen found principally in Southern Europe.

(11) Other natural gums derived from the fruit of the carob tree, an evergreen found principally in southern Europe.

(12) Pectin is a general term for a group of water-soluble and water-dispersible polysacharides present in the cell walls of all plant tissues.

(13) A relatively recent type of water-soluble, natural polymer is that produced as an extracellular polysaccharide by bacteria or fungi. Included among these are xanthan gum, polysaccharide Y-1401, scleroglucan and various dextrans.

There are also some starch derivatives which meet many of the criteria outlined for a mucosal-tenacious, water-soluble or water-dispersible polymer above, but are not usable in this invention because of their susceptibility to amylolytic degradation from the enzyme ptyalin found in saliva.

In addition to the natural hydrophilic polymers, the following synthetic polymers may also be used:

1. Chemical modification of cellulose provides many derivatives which are useful within the teachings of this invention. Among these are methyl cellulose, sodium carboxymethylcellulose, hydroxypropylmethylcellulose, hydroxypropylethylcellulose, hydroxypropyl cellulose; and ethylhydroxyethyl cellulose. These agents can be prepared in a wide range of solubility and viscosity ranges.

2. Polyvinyl alcohol is produced by the alcoholysis of polyvinyl acetate and can be made in a number of molecular weights, water-solubility ranges and viscosity ranges.

3. Polyvinylpyrrolidone is a homopolymer of N-vinylpyrrolidone with a high level of water solubility and pronounced viscosity-building properties.

4. Polyacrylic acid derivates can be used directly but more often are used with other copolymers; an important polyacrylic acid copolymer is polycarbophil.

5. Particularly useful materials are the partial calcium/sodium salts of lower alkyl vinyl-maleic acid anhydride copolymers, sold commercially as "Gantrez" and "Ucarset (Trade Marks).

6. Polyacrylamide is a polymer of acrylamide and can be polymerized by a variety of synthetic approaches.

7. Ethylene oxide polymers of very high molecular weight are commercially sold by the Union Carbide Co. as water-soluble resins ("Polyox" (Trade Mark)). They range in molecular weight from a few hundred thousand to five million or more. The higher molecular weight derivatives have extraordinary viscosity-building effects in water and other solvents, as well as pronounced mucosal-tenacity.

8. Polyethylenimines are produced from the monomer ethylenimine in the presence of an acid catalyst. They are of special interest for adherent formulations because of their tendency to form strong electrostatic bonds.

It is also possible to use at least one material of animal origin:

1. Gelatin is a partially hydrolized protein derived from the skin, connective tissues and bones of mammalian animals; that derived by acid treatment is Type A and that from alkali treatment is Type B.

These various polymeric materials herein described are illustrative of the many agents from which a composition can be compounded into useful mucosal-tenacious carriers. They may be used singly or in combination, in a wide range of concentrations, and in the presence of many other agents intended to control rates of water absorption and swelling, ingredients to enhance tissue penetration, various fillers, buffers, sweeteners, flavors, bodying agents and other pharmaceutical necessities.

Generally, such compositions include 0.01 to about 10 parts antioxidant, 0.01 to 10 parts arylpropionic, NSAID, and 20 to 60 parts mucosal-tenacious polymer.

Examples 1-7 below are illustrative of pharmaceutically acceptable carriers with synergistic compositions therein which can be used in accordance with the teachings of the invention.

Example 1

Components		% By Weight
1.	CMC 7H3SXF (Sodium Carboxymethylcellulose)	10.0
2.	Polyox®(Polyethylene Oxide)	20.0
3.	Polycarbophil	10.0
4.	Calcium Oxide	1.0
5.	Ketoprofen	1.0
6.	Alpha-tocopherol	1.0
7.	Polyvinylacetate	23.0
8.	Triacetin	34.0
		100.0

Polyvinylacetate and triacetin were pre-mixed in a sigma-blade mixer. CMC 7H3SXF, polyox® powder, polycarbophil, calcium oxide, and ketoprofen were homogeneously mixed in a TekmarK (Trade Mark) mixer, followed by the addition of alpha-tocopherol at 1000 rpm. Finally, the polyvinylacetate/triacetin pre-mix was added to the mixture, and resulted in a smooth cream-type product.

Example 2

Components	% By Weight
1. Mineral Oil	51.45
2. CMC 7H3SXF (Sodium Carboxymethylcellulose)	32.0
3. Polyox® (Polyethylene Oxide)	13.0
4. Propylparaben	0.05
5. Sodium Monophosphate	0.10
6. Flavor (Spray Dried)	0.40
7. Ketoprofen	2.0
8. Alpha-tocopherol	1.0
	100.0

Mineral oil was heated to 65°C in a Kitchen-Aid (Trade Mark) Bowl. CMC 7H3SXF, polyox, propylparaben and sodium monophosphate were slowly charged to the bowl and mix-homogeneously for 10-15 minutes. Finally the active agents (alpha-tocopherol and ketoprofen) and flavor were added and mixed thoroughly.

Example 3

Components	% By Weight
1. Ethanol	15.0
2. Glycerin	15.0
3. Polysorbate	1.0
4. Sodium Lauryl Sulfate	0.1
5. Ketoprofen	1.0
6. Alpha-tocopherol	1.0
7. Flavor	0.1
8. Colorant (FD&C Grade)	0.005
9. Water	66.795
	100.0

Active agents (alpha-tocopherol and ketoprofen) were mixed homogeneously with ethanol in a container. In another container, flavor, glycerin, sodium lauryl sulfate, colorant and polysorbate were mixed together, followed by the addition of water. The ethanol (and active agents) solution was then charged to the aqueous portion and mixed thoroughly.

Example 4

Components	% By Weight
1. Ethylene Oxide Homopolymer	40.0
2. Polyvinylpyrrolidone	40.0
3. Polyethylene Glycol 4000	14.9
4. Glycerin	1.0
5. Ketoprofen	2.0
6. Alpha-tocopherol	2.0
7. Flavor	0.1
	100.0

The first four ingredients are homogenized into an intimate mixture and warmed to about 40°C. The active agents and flavor were incorporated into the mixture and mixed thoroughly. The final mixture was cooled to about 25°C and then extruded through stainless steel rollers into a film approximately 2mm thick.

Example 5

Components	% By Weight
1. Ketoprofen	2.0
2. Alpha-tocopherol	2.0
3. Hydrated Silica	12.0
4. Sorbitol Solution	12.0
5. Glycerin	12.0
6. Xanthan Gum	1.5
7. Fumed Silica	2.0
8. Flavor	0.5
9. Propyl Paraben	0.05
10. Methyl Paraben	0.05
11. Sodium Lauryl Sulfate	1.5
12. Water	54.4
	100.0

In a mixing vessel container fitted with a vacuum system and mixing apparatus, water, active agents, parabens, flavor, sorbitol solution, and silica were charged and mixed thorougly. In a separate container xanthan gum was charged and mixed in glycerin and then charged to the mixing vessel. It was then mixed for about 10 minutes, detergent was added, and finally mixed under full vacuum for 20-30 minutes.

Example 6

Components	% By Weight
1. Lactose	57.0
2. Avicel® (pH 101) (Trade Mark)	33.0
3. Starch	4.0
4. Fumed Silica	1.0
5. Stearic Acid	2.0
6. Alpha-tocopherol	2.0
7. Ketoprofen	1.0
	100.0

Active ingredients (alpha-tocopherol and ketoprofen) were mixed homogeneously with lactose in a Ribbon mixer followed by the addition of Avicel®, starch, fumed silica and finally stearic acid. Manesty equipment was used to produce tablets (average weight: 500 mg.).

Example 7

Components	% By Weight
1. Lactose	80.0
2. Starch	17.0
3. Alpha-tocopherol	1.0
4. Ketoprofen	1.0
5. Fumed Silica	1.0
	100.0

Alpha-tocopherol was homogeneously dispersed with lactose in a Ribbon Mixer, followed by ketoprofen, starch and fumed silica. After the powder was homogeneously mixed, it was then filled into hard gelatin capsules at an average weight of 500 mg. using an MG-2 automatic capsule filling machine.
The use of the term 'Trade Mark' herein is intended to indicate that the word is used as a trade mark and may

be registered in one or more of the States designated in the application.

Claims

1. The use of an anti-inflammatory drug in the preparation of a pharmaceutical composition for the topical treatment of periodontal disease to prevent destruction of tissue supporting the teeth, characterised in that ketoprofen is used as the anti-inflammatory drug in combination with alpha-tocopherol in a carrier comprising a semi-solid paste, gel, liquid, ointment or film which has a strong and continuing adherence to the oral mucosa, the amounts of anti-inflammatory drug and alpha tocopherol each being from 0.01 to 10% by weight of the composition.

2. Use as claimed in Claim 1, wherein the amount of the alpha-tocophenol is from 0.03 to 2.0% by weight and the amount of the arylpropionic, non-steroidal anti-inflammatory drug is from 0.01 to 2% by weight.

3. Use as claimed in Claim 1 or Claim 2, wherein the carrier comprises a water soluble or water dispersible polymer.

4. Use as claimed in Claim 3, wherein the combination of the composition and the carrier comprises (by weight) 0.01 to 10 parts of alpha tocopherol, 0.01 to 10 parts of ketoprofen, and 20 to 60 parts of said polymer.

5. Use as claimed in Claim 4, wherein the polymer is selected from karaya gum, ethyleneoxide polymer, sodium carboxy-methyl cellulose and lower alkyl vinyl ether-maleic acid anhydride copolymer.

Patentansprüche

1. Verwendung eines entzündungshemmenden Medikaments bei der Herstellung einer pharmazeutischen Zusammensetzung zur topischen Behandlung der Periodontalen Erkrankung zur Verhinderung der Zerstörung von die Zähne tragendem Gewebe, **dadurch gekennzeichnet, daß** Ketoprofen als das entzündungshemmende Medikament in Verbindung mit Alpha-Tocopherol in einem Trägerstoff verwendet wird, umfassend eine halbfeste Paste, ein Gel, eine Flüssigkeit, eine Salbe oder einen Film, der eine starke und kontinuierliche Haftung an die Mundschleimhaut aufweist, wobei die Mengen an entzündungshemmendem Medikament und Alpha-Tocopherol jeweils 0,01 bis 10 Gew.-% der Zusammensetzung betragen.

2. Verwendung nach Anspruch 1, **dadurch gekennzeichnet, daß** die Menge an Alpha-Tocopherol 0,03 bis 2,0 Gew.-% beträgt und die Menge des arylpropionischen, nicht-steroidalen entzündungshemmenden Medikamentes 0,01 bis 2 Gew.-% beträgt.

3. Verwendung nach Anspruch oder Anspruch 2, **dadurch gekennzeichnet, daß** der Trägerstoff ein wasserlösliches oder wasserdispergierbares Polymer umfaßt.

4. Verwendung nach Anspruch 5, **dadurch gekennzeichnet, daß** die Kombination aus der Zusammensetzung und dem Trägerstoff 0,01 bis 10 Teile Alpha-Tocopherol, 0,01 bis 10 Teile Ketoprofen und 20 bis 60 Teile des Polymers (bezogen auf das Gewicht) umfaßt.

5. Verwendung nach Anspruch 4, **dadurch gekennzeichnet, daß** das Polymer aus Karaya-Gummi, Ethylenoxid-Polymer, Natriumcarboxymethylcellulose und Niedrigalkylvinylether-Maleinsäureanhydrid-Copolymer ausgewählt ist.

Revendications

1. Utilisation d'un médicament anti-inflammatoire dans la préparation d'une composition pharmaceutique pour le traitement topique des maladies periodontales, en vue de prévenir la destruction des tissus qui supportent les dents, caractérisé en ce que l'on utilise le kétoprofène comme médicament anti-inflammatoire, en combinaison avec l'alpha-tocophérol, dans un support comprenant une pâte semi-solide, un gel, un liquide, un onguent ou un film présentant une adhérence forte et continue vis à vis de

la muqueuse orale, les quantités de médicament anti-inflammatoire et d'alpha-tocophérol étant chacune de 0,01 à 10 % en poids de la composition.

2. Utilisation selon la revendication 1, dans laquelle la quantité d'alpha-tocopherol est de 0,03 à 2,0 % en poids et la quantité de médicament anti-inflammatoire arylpropionique non stéroïdal est de 0,01 à 2,0 % en poids.

3. Utilisation selon la revendication 1 ou la revendication 2, dans laquelle le support comprend un polymère hydrosoluble ou hydrodispersible.

4. Utilisation selon la revendication 3, dans laquelle la combinaison de la composition et du support comprend, en poids, 0,01 à 10 parties d'alpha-tocophérol, 0,01 à 10 parties de kétoprofène et 20 à 60 parties dudit polymère.

5. Utilisation selon la revendication 4, dans laquelle le polymère est choisi dans le groupe formé par la gomme de karaya, le polyéthylène-oxyde, la carboxyméthyl cellulose sodique et un copolymère d'anhydride maléique et d'éther alkyl vinylique dont le groupe alkyle est un alkyle inférieur.